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H5H
Selected US specifications from IPC sub-class H05B

(54) Controlling cooking time

(57) In a cooking oven 1 in which the output of a food probe 2 inserted in a food item 3 is compared with a preset temperature to determine when the food item is cooked, there is provided means such as a microprocessor 7 to predict the time at which the food will be cooked. Repeated measurements are made of the food probe temperature to estimate when the pre-set temperature will be reached. This information is used to control the cooking means 5 to finish the cooking at a preset end time programmed in by the user.

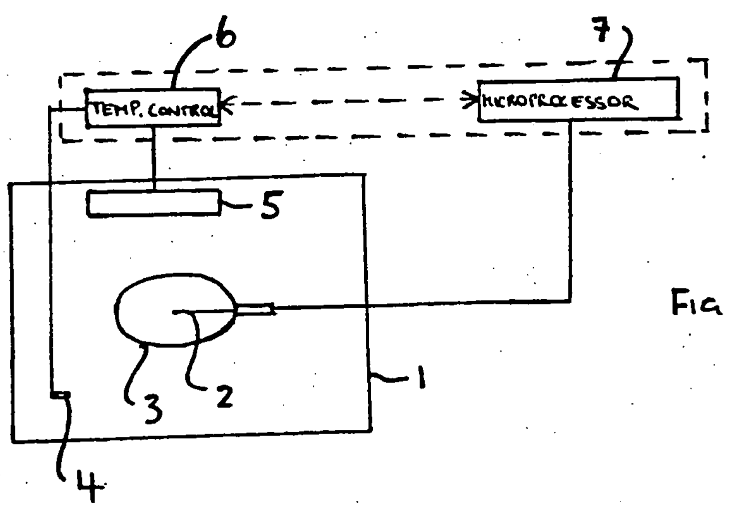

Fig 1

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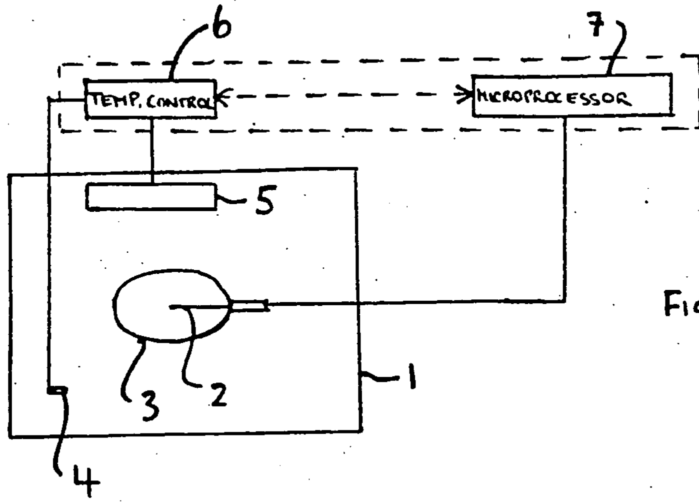

Fig 1

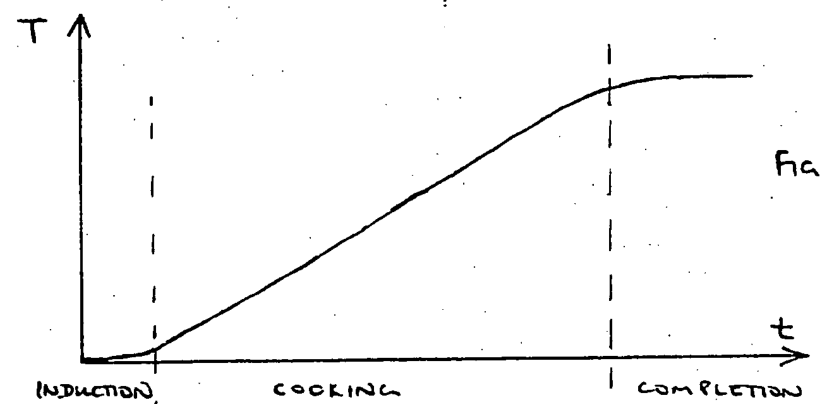

Fig 2

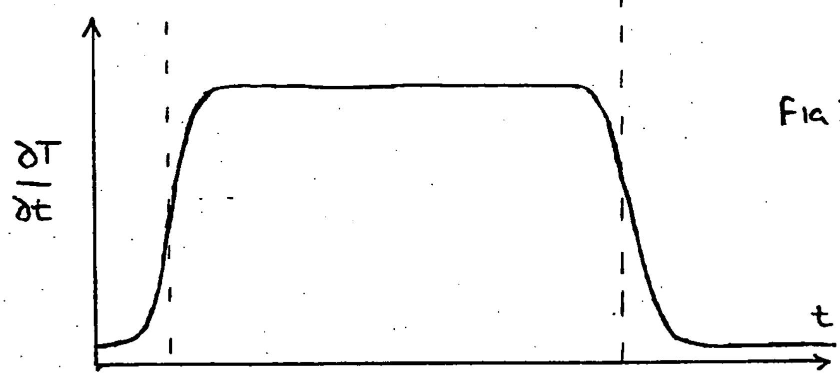

Fig 3

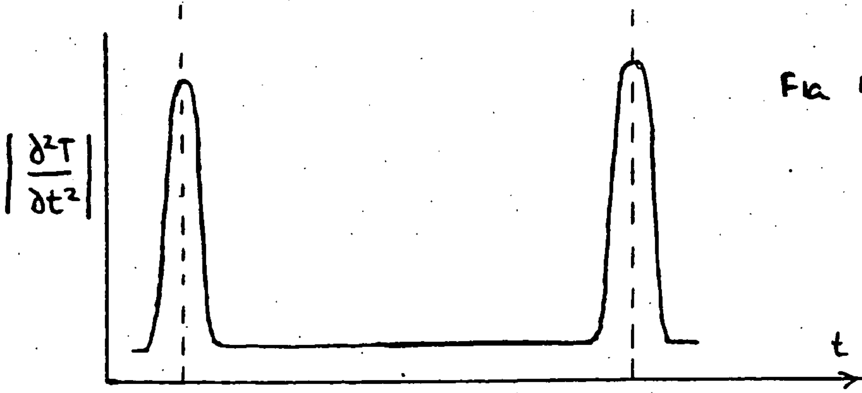

Fig 4

Cooking Ovens

This invention relates to cooking ovens and more specifically to cooking ovens which incorporate a temperature probe. Such probes are inserted into a food item to be cooked and indicate the internal temperature of the food item. Better results are often attainable by cooking a food item until a predetermined internal temperature has been reached rather than simply cooking it for a predetermined length of time. The oven may take any covenient form and may be a conventional gas oven, a conventional electric oven, a microwave oven or a combination microwave/fanned convection oven, the fanned convection oven being either electrically or gas heated.

It is known to provide a microwave oven with a temperature probe which is inserted into a food item to be cooked and which affords an output indicative of the temperature of the food item. Typically, it may be arranged that a required probe temperature is preset into the oven and an audible alarm activated when that temperature is reached, this being indicative of the food item being cooked.

In accordance with the present invention there is provided a cooking oven comprising a food probe for insertion in a food item to be cooked and for affording an output indicative of the temperature thereof, cooking means for causing said food item to be cooked, means for comparing the output of the food probe with a preset

temperature for determining when said food item is cooked, timer means for presetting a required time at which said food item is to be cooked, and means operable in conjunction with the output of said food probe for controlling the cooking means whereby the time at which said food item is cooked substantially corresponds to said preset time.

In a preferred embodiment of the invention, processor means will be provided for determining the rate of temperature rise of said food probe for predicting the time at which said food item will be cooked and for controlling the cooking means whereby the predicted time substantially corresponds to said preset time.

In carrying out the invention the cooking means may take the form of a gas or electric heat source, a microwave energy heat source e.g. a magnetron or a combination microwave/fanned convection heat source, this latter being either electrically or gas heated.

Typically, in use of a cooking oven in accordance with the present invention, a food item to be cooked will be placed in the oven with the food probe inserted in it. The oven will be provided with a control which is preset to the probe temperature that corresponds to the particular food item being cooked and also with a timer control which is preset with the required end time that the food item is required to be cooked by. The oven is then set in operation by setting a required microwave energy level, temperature level or combination thereof as

the case may be. The cooking oven will be provided with a suitable processor whereby the temperature of the food item as measured by the food probe may be measured at regular intervals, in order to determine the rate of temperature rise, and this may be compared by the processor with an expected model curve in order to predict the time the food item will be cooked. As the cooking proceeds, the prediction is likely to increase in accuracy, so that the predicted time may be periodically updated. The predicted cook time is then compared by the processor with the preset 'end time' and the energy level and/or temperature of the oven adjusted to ensure that the food is cooked, but not overcooked, at the required end time. In the case of a conventionally heated oven the temperature of the oven may be adjusted; in the case of a microwave oven, the magnetron power may be adjusted (e.g. by varying a mask-space control switch); and in the case of a combination oven both temperature and power may be adjusted.

It has been found that the temperature rise is actually approximately linear after an initial period and further that the transition between the initial period and the linear period is approximately denoted by a peak in the second derivative of the probe temperature with respect to time. To obviate the need to store a model curve therefore, once the peak has been detected, the finishing time may be predicted on the basis of a linear temperature rise.

A cooking oven constructed in accordance with the invention will now be described by way of example with reference to the accompanying drawing, in which:

Figure 1 is a block diagram showing sensors and circuitry of the oven;

Figure 2 is a graph of temperature against time for a typical food item;

Figure 3 is a graph of the first derivative of the curve of figure 2; and

Figure 4 is a graph of the modulus of the second derivative of the curve of figure 2.

Referring to figure 1, the oven 1 has a food probe 2 embedded in a food item 3 and an oven temperature sensor 4. The food probe, which consists of a hollow tube with a thermistor at the tip, is positioned as far as possible so that its tip lies in the centre of the food item. The oven is also provided with heating means 5. The heating means 5 is controlled by an oven temperature control 6 which also has inputs from the oven temperature sensor 4 and a microprocessor 7. Means (not shown) is also provided for entering the temperature which it is desired that the probe tip should reach as well the required finishing time.

The oven handbook lists appropriate probe tip temperatures to programme in, which depend on the type of food e.g. the type of meat, and how moist e.g. in the case of beef how rare or how lean, it is desired the item should be. The item is cooked when this temperature is

reached, and this produces more predictable cooking results than if the cooking time is simply specified.

Referring to figure 2 a graph of the temperature of the probe tip during the cooking process is shown for a typical food item e.g. a joint of meat. The cooking process has been found to fall into three phases. First, an induction phase in which the oven and the food item are being heated from ambient. Second, the cooking phase, during which the rise in temperature of the probe tip is substantially linear with respect to time. And, thirdly, completion, during which the temperature remains substantially constant. This latter temperature cannot be higher than the boiling point of water and, depending on the size and nature of the food item, is typically lower, say 80°C or 90°C.

Referring to figures 3 and 4, the first and second derivatives of the food probe temperature curve are calculated in the microprocessor 7 and take the form shown in figures 3 and 4.

In operation, the food item is inserted into the oven and the desired probe tip temperature and required finish time are set. The heating means 5 then heats the oven and the induction phase, in which the oven and the food are heated from ambient, begins. The temperature of the end of the probe begins to rise slowly. After a certain length of time, temperature of the centre of the food begins to rise at a higher and approximately uniform rate, indicating the onset of the cooking period. This point is

indicated by a spike in the second derivative of the probe temperature with respect to time, since the temperature rise first accelerates to that of the cooking phase and then decelerates to the approximately constant rate of rise of the cooking phase itself.

Once the first spike has been passed, the microprocessor makes several measurements of temperature with respect of time and an average of the rate of rise of temperature is produced. The microprocessor then calculates the time at which the pre-set probe tip temperature will be reached and compares this with the pre-set end time. The energy level and/or temperature of the oven are then adjusted to ensure that the food is cooked, but not overcooked, at the required end time.

Thus, the oven has the advantages of the more predictable cooking produced by using a heat probe and also of finishing the cooking at a time convenient to the user.

In order to obtain a more accurate indication of the final cooking time, the microprocessor may estimate repeatedly the time for completion of the cooking during the cooking process and update the display accordingly.

When the final probe tip temperature has been reached at the pre-set end time, the oven heating means may be switched off. If desired, however, the second spike on the second derivative of the temperature/time curve, which indicated the transition between the cooking phase and the completion phase, may be used instead to switch the oven

heating means off. Or the oven heating means may be switched off after a predetermined delay from the reaching of the pre-set probe temperature and end time or the second spike.

The invention is applicable to microwave ovens, or to combination microwave/fanned convection ovens (the fanned convection being either electrically or gas heated), or is applicable to conventional gas or electric ovens.

The invention is especially appropriate to food items such as joints of meat, but may not be applicable to certain items e.g. casseroles. For this reason, the food probe may be disconnectable e.g. via a jack plug and socket and a conventional timer, as well as manual controls and oven temperature or microwave energy controls may be provided as well.

CLAIMS

1. A cooking oven comprising a food probe for insertion in a food item to be cooked and for affording an output indicative of the temperature thereof, cooking means for causing said food item to be cooked, means for comparing the output of the food probe with a preset temperature for determining when said food item is cooked, timer means for presetting a required time at which said food item is to be cooked, and means operable in conjunction with the output of said food probe for controlling the cooking means whereby the time at which said food item is cooked substantially corresponds to said preset time.

2. A cooking oven as claimed in claim 1, comprising processor means for determining the rate of temperature rise of said food probe predicting the time at which said food item will be cooked and for controlling the cooking means whereby the predicted time substantially corresponds to said preset time.

3. A cooking oven as claimed in claim 2, comprising means to measure the second derivative of the variation of probe temperature with respect to time, and in which the processor means is arranged to determine the rate of temperature rise of the food probe after a peak has occurred in the second derivative.

4. A cooking oven as claimed in claim 3, in which the processor means is arranged to repeatedly predict the time at which the food item will be cooked.

5. A cooking oven as claimed in any one of claims 1 to

4, in which the oven is a microwave oven.

6. A cooking oven as claimed in any one of claims 1 to 5, in which the oven is a combination microwave and electric or gas heated oven.

7. A cooking oven as claimed in any preceding claim and substantially as hereinbefore described.

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